Abstract A novel printed antenna resembling a truncated SINC function is proposed for wireless communications. The proposed antenna functions either as a twisted dipole or two twisted back-to-back connected L-shape dipoles depending on the current mode. Due to the symmetry, the antenna supports an even or odd mode of current on the antenna and results in different design and performance considerations. The SINC antenna is suitable for WLAN single or dual frequency operation. Several examples of the design are discussed.

Introduction

Recently there is tremendous demand for the development of wireless communication systems for local access networks including bluetooth, IEEE 802.11a, and 802.11b. This demand has stirred significant renewed interest in antenna design particularly at the ISM bands. Many novel antenna structures for single, dual, or multiple bands have been proposed [1-3]. Among them, printed circuit antennas are desirable for their low cost, low profile, and conformality. Furthermore, the material substrate provides substantial antenna size reduction. A drawback is the narrow bandwidth, when a conductor backing is presented. Parasitic elements may be used to provide multiple resonances to enhance the bandwidth.

In this paper, we propose a novel printed wire-type antenna with the shape of a truncated SINC function. The generic antenna shape is shown in Figure 1. The geometry is basically a twisted wire. The antenna is also like two compressed L-shape antennas connected back-to-back. The antenna can be microstrip, slot, or slot over a microstrip patch. An advantage of this antenna is that it provides an optimised antenna area resulting in substantial reduction of the length of a typical wire antenna. Due to the symmetry of the structure current on the wire can be excited either symmetrically (an even mode) or anti-symmetrically (an odd mode). Either a coaxial probe or a microstrip-type transmission line can be used as the feed for the antenna. The feed also serves as interconnect between antenna and the systems.
Design Considerations

The proposed printed SINC antenna is for single, dual or multiple band WLAN applications. It is possible to design a multi-band antenna with desired bandwidth at both 2.44 GHz and 5.25 GHz. However, since printed circuit antennas provide very good out of band rejection and isolation between antennas of different bands, it is desirable to have two antennas of different bands in close vicinity fed separately. In this paper we will describe the design of the SINC antenna for each band and discuss the isolation issue for the two antennas of different bands.

Based on the direction of current on the SINC antenna, we can classify the antenna into two categories. If the current flow is from the left side to the right side of the antenna (Figure 1) and reaches the peak at the mid-point (the tip), the antenna is operated at an odd mode where the antenna resembles a twisted half-wavelength dipole. On the other hand, if the current is zero at the mid-point and at the two ends, the antenna resembles two-twisted L-shape antennas connected back-to-back and is operated at an even mode. Depending on the specific requirement, both even and odd mode SINC antennas would be useful. The odd-mode antenna is like a compressed half-wavelength dipole and is useful for size reduction. A typical printed dipole antenna has very high radiation resistance at resonance. The odd-mode antenna is useful for resistance reduction since the central two-arm radiation tends to cancel out. Even-mode antenna tends to provide better bandwidth since half of the antenna serves as a parasitic element that introduces an additional resonance. The antenna height and width ratio is not crucial in the design and the value in the range of 0.8~1 is adequate for optimised overall area. The strip width is also flexible in the design and a few mm is typical. Too thin of the strip width will result in too high of the resistance at resonance.

Design Examples

Several printed SINC antennas are designed, simulated and tested on a FR4 material. The substrate is made of three layers with thickness 0.229mm, 1.245mm, and 0.229mm, respectively. The design assumes the FR4 has a dielectric constant 3.9 and a loss tangent 0.01. The IE3D full-wave simulator, based on integral-equation moment-method, is used for the design. A coaxial probe is used as the feed for the antenna. An even-mode printed antenna is designed for 2.43 GHz with about 60MHz bandwidth. The picture of this antenna and the measured return loss versus frequency are shown in Figure 2. The antenna has width of 37.6 mm and height 31.7 mm. The structure is inherently narrow band. A parasitic half-SINC shape element is placed underneath the antenna to increase the bandwidth. The 10dB bandwidth is about 2.5%. The radiation patterns of this antenna are shown in Figure 3. For this even-mode antenna, the main current is pointing down in Figure 1 (in the negative y-axis) and the antenna is assumed in the x-y plane. The E-plane is the y-z plane and the H-plane is in the x-z plane. There is about 10-20 dB backside radiation due to finite size of the ground plane. The patterns are measured at 2.43 GHz and with 2dBi gain. The probe location is optimised with IE3D simulator to provide 50ohm match. Note that the E- and H- plane
will interchange when the antenna is at odd mode resonance.

Another even-mode antenna is designed at 5.2 GHz, which is almost a scale-down of the 2.43GHz antenna. The width is 17.3 mm and the height is 14.8 mm. A half-SINC shape parasitic element is placed at lower layer to provide double resonance matching. The picture of this antenna right next to the 2.43GHz one is shown in Figure 4 together with the measured return loss of this antenna. The 10dB bandwidth is about 3.5%. In order to explore the possibility of dual-feed and dual-band applications, the two designed antennas are brought close together and a two-port S-matrix measurement is performed to determine the isolation of these two antennas. It is found that the arrangement shown in Figure 5 provides very good isolation (-50dB at
2.43GHz and –35 GHz at 5.2 GHz) while maintaining small overall antenna size. There are two main reasons for this excellent isolation. One is the high out of band rejection characteristics due to the narrow band and the other is the low radiation on the substrate plane, an inherent property of printed circuit antennas.

Reference